

The following is a true copy of my laboratory notes, Volume 1, covering the period October 5, 1951 to July 7, 1953, pages 1-218a, with a number of unnumbered pages included.

There are two additional volumes of my notes, one of which is labelled "Summaries".

In this first volume there are a number of unnumbered pages at the front which represent an index, but it should be noted that at page 110 there is a statement "not indexed beyond here".

The chief interest in these notes will be for the specialized transduction produced by the bacteriophage lambda and its discovery. However, many of the notes deal with other matters. Each of us in the Lederberg laboratory had some side assignments and some of these, such as isolation of mutants in E. coli strains believed fertile with K-12, radiation resistance as a function of ploidy and lysogenicity for phage, phage induction by UV, and others were my assignments.

The discovery of the special transduction by lambda was not planned. It came shortly after the discovery of generalized transduction by phage PLT22 in Salmonella by Zinder and Lederberg, and was followed several years later by the generalized transduction in E. coli by phage P1 by Lennox.

As I was producing large amounts of phage lambda in some radiation experiments I was curious as to whether lambda transduced any genetic material. I tried my first transduction (for methionine independence) on March 26, 1952 (page 47) and of course it didn't work. I tried the same experiment again a few days later (pages 48,50).

It is my recollection that Norton Zinder and I were alone in the lab while the Lederbergs were at a meeting at Rutgers University in March or April of 1952, when Norton and discussed the possibility of lambda transducing genetic material. I recall that Norton said he thought that Esther Lederberg had tried some experiments with lambda but he did not know what they were. Since I had a lot of lambda preparations I suggested that we try and so we took all the selective medium plates available, and appropriate recipient strains and mixed lambda and cells and plated them out.

I have always thought that chance played a big part in Norton Zinder's failure to discover special transduction. Norton worked with Salmonella which do not metabolize lactose and therefore he had no EMB lactose plates, on which the first lambda transductions were observed.

It was my good fortune to have had the EMB lactose plates which provided the selective environment for gal<sup>+</sup> clones.

However, it was still baffling in that the papillae on EMBlac produced by lambda and quantitatively related to the amount of lambda used - proved to be lac<sup>-</sup> on further examination. I spent much of April 1952 trying to resolve this confusion. It was at this point that Esther Lederberg suggested, on the basis of her prior knowledge and experience with lac-gal interactions and the strains that I was using, that I should look at lambda transduction in terms of selection of gal<sup>+</sup> clones. So on May 5, 1952 (page 71) I began studying lambda transduction of gal genes on EMB galactose, and it all began to come out. Much more was needed to be done: lambda as vector had to be established; the heterogenetic character of the transductants elucidated; the identification of the alleles involved in the segregants when the donor and the recipient were gal<sup>-</sup>; quantitative relationships established; the discovery of high frequency (HFT) transducing lysates; that the phage in some of the transductions was a defective phage, and other things.

It was an exciting time and it was an exciting experience and the stimulation by the people in the crowded lab helped - the Lederbergs, Zinder, Alec Bernstein, Tom Nelson, Bob Wright, Luca Cavalli-Sforza, Gaylen Bradley, Tetsuo Iino, Dorothy Gosting, and probably others I overlook.

Prior to writing this introduction I made an audio tape that discusses the rest of my notes in Volume 1, and perhaps when it is transcribed it can added to this copy.

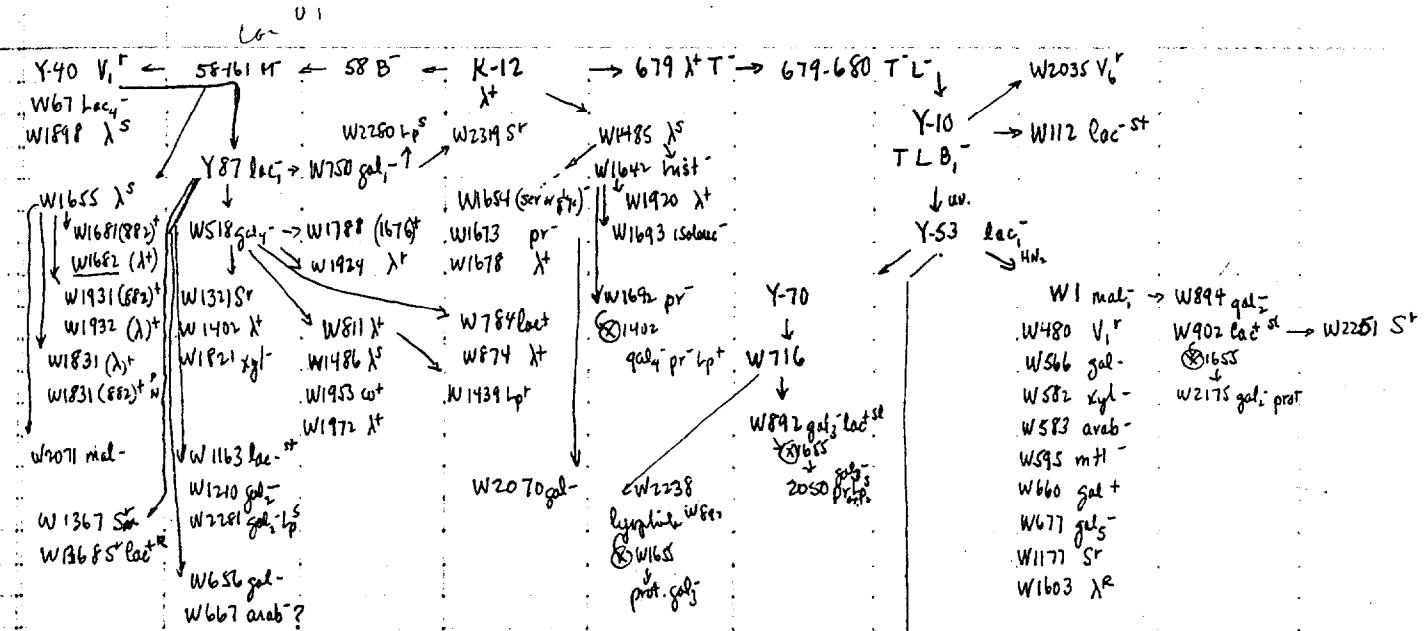
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July 23, 1986.

Research Notes Vol. I

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58-161

W-416  $V_r V_h$  ⊗ Y-64  $V_r$

Y-53 ?

Y-64  $V_{1a}$

W-465 = H1

W-477 ?

W-1296  $X^+$  ← W-588 lac<sup>+</sup> ⊗ W-518

H217

↓ segregation

W-1267 (flb) lac<sup>-</sup> gal<sup>+</sup>  $X^+$

W-1436 Sr

W-1661 (882)<sup>+</sup>

W-2196 mol-

W-2202  $V_r$

W-2234 F<sup>-</sup>

Cultures on Hand 8/20/53

✓	K-12
✓	58-161
✓	W67
✗	W578
✓	W588
✓	W687
✓	W750
✓	W811
✗	W874
✓	W892
✓	W902
✓	W1177
✗	W1210
✓	W1368
✓	W1902
✓	W1436
✓	W1439
✓	W1485
✓	W1503
✓	W1655
✓	W1673
✓	W1678
✓	W1692
✓	W1808(31)
✓	W1821
✓	W1924
✓	W2035
✓	W2050
✓	W2062
✓	W2070
✓	W2071
✓	W2175
✓	W2196
✓	W2202
✓	W2251
✓	W2280
✓	W2281
✓	W2297
✓	W2319

<u>Subject</u>	<u>Pages</u>
Gel directions	
W161	47, 82
W518 gel <sub>4</sub> -	54, 92(sup), 93, 95(2), 97(stable) (S18(16-12)*) 99(stable)
W1655	48, 49, 50, 51
W1736 gel <sub>4</sub> -	59, 61, 62, 65(goo), 71(goo) 72(sup), 74(goo), 75(goo), 76(goo), 77, 78(goo), 80(goo), 81(lab), 82, 83(acetate), 86, 87, 88(1415) 95(stable) 96(stable), 99(4,4) (stable),
W112	71, 83(princip.), 85, 94 (derived)
W1678	74, 76
W1662	80, 82, 84
W811 gel <sub>4</sub> -	81, 82, 83(BM), 84, 86, 87, 88(sup), 89(S18(16-12)), 92(80-1), 93, 94, 96(818(16-12)) <sup>818(16-12)</sup> , 99(4,4) (stable), 103(stable)
W1439 gel <sub>4</sub> -1 <sub>p</sub> , f	82
W1821 gel <sub>4</sub> -	83(4,4), 85(gel, xg, BM), 87
W902 gel <sub>2</sub> -	88, 100(derived) 110(derived) 150(18-12)
W750 gel <sub>1</sub> -	88, 91, 93(sup), 94(750), 96(stable)(200-90), 98, 99(4,4) (stable), 105(stable), 107(stable)(stable-1), 109(stable)
W1692	96
W1920	96
W2057 gel <sub>3</sub> -	99(K-12), 106, 107(stable)
W1578 gel <sub>4</sub> , F-	99
W2062	100, 101, 104, 105, 106 102, 103, 104(16-12), 104(16-12), 106, 107(stable), 109(stable).
W1929	
Adsorption Exp.	89

SubjectTransductins

58-161 (b<sub>3</sub> K-12)  
 W518 (b<sub>3</sub> K-12)  
 W1655 (b<sub>3</sub> K-12)  
 W1736 (b<sub>3</sub> K-12)  
 W1112 (b<sub>3</sub> K-12)  
 W1678 (b<sub>3</sub> K-12)  
 W1662 "  
 W871 "  
 W1431 "  
 W1821 "

Pages

47, 82  
 59  
 48, 49, 50, 51  
 59, 61, 62, 63, 64 (gal) 71 (gal), 72 (lac), 74 (gal), 75 (lacuvine), 76 (lac), 77, 78 (lac)  
 71, 83 (lacuvine), 83 (lac)  
 74, 76  
 80, 82, 84  
 81, 82, 83 (lac), 84, 86, 87  
 82  
 82, 83 (gal), 84 (lac), 85 (lac), 87

86, 87  
 85a (acetoate)  
 85b (lac)  
 85c (lac)  
 85d (gal)

Reconstruction eq.

p2.

Crosses

58-161 X W914 pr- trypt-  
 W1112 X W1655 [X 718, <sup>W</sup>shake X <sup>18</sup>shake]  
 W902 X W1655  
 811 tK-r X 1436  
 518 tK-12 X 1436  
 780 X 1603  
 (177 X 1655)

50, 52  
 85c, 88, 91  
 95, 96, 98, 100 (lac)  
 100, 101, 102 (+), 103 (-), 104 (os repeat), 106, 107 (chitin), 108, 109  
 100, 101, 102 (-), 103 (+), 105 (repeat), 106, 107

SubjectPages

Lwoff effect with λ (for other phages see particular strain)

determined

by gross examination

K-12

26, 30, 32, 33, 36, 38, 43, 51, 61, 90

SB-161

36, 38, 39, 43, 92

W67

57

W1177

57

W1661

59

W1662

59

W1736

59, 67, 90 (μ<sup>+</sup>)

W1682 (μ<sup>+</sup> prep)

63

H267

58

90<sup>r</sup>

90<sup>r</sup>

W1821

90

W811

90, 90 (μ<sup>+</sup> prep),

750

94

W1939

98

by plaque count (see also λ prep.)

K-12

22\*, 23\*, 53\* (aggr), 68 (S91, c.w.b) 69\*

K-12A, K-12B

34, 35\*

W1177

13\*

W1678

58

W1932

62\*

H267

60\*, 68\*

W1682 (μ<sup>+</sup> prep)

63

W1954 (μ<sup>+</sup> prep)

69\*

W1972 (μ<sup>+</sup> prep)

69\*, 78\*

W1998 (μ<sup>+</sup> prep)

78\*

effected by post incubation:

K-12

29, 25, 26

W1177

13\*

W1603

13

W1736 gal<sup>+</sup>

88

W811 gal<sup>+</sup>

88

S184L<sup>-</sup>

102

S111EKL<sup>-</sup>

102

SubjectPages

λ Preparations

K-12 vs λ  
 K-12 L1 PX  
 L2 PX  
 L3 PX  
 L4 (PX + Spn.)  
 L5 PX  
 L6 (Pvn)  
 L7 (Pvn)  
 L8 (Spn)  
 W67 L1  
 58-161 L1  
 L2  
 L3 (Pvn)  
 W1177 L1  
 W1485  
 W1662  
 W1655  
 W1736  
 W811  
 H267 L1

51  
 -  
 32  
 32  
 33  
 -  
 43, 47  
 51, 68 { continue } 73, 80 (mech) 80  
 59, 68 (Fitted) 68, 61, 62  
 37,  
 -  
 93, 93  
 59, 71, 80  
 39, 35  
 59  
 39, 49 (agar) 48 (99.0)  
 59, 71, 74, 80, 80 (spore)  
 84, 84, 85, 86, 90, 90 (80+)  
 58, 59  
 69, 74, 77  
 K2, 90, 73  
 80, 83  
 93  
 99  
 16

882 prep

1821

Jrrd. of λ 902

750

W1489 - 98

Dose Extension Summary - Pedigree

## New Isolates

K-12A K-12B  
 W1655 (882)  
 W1831 (882)  
 W-1872 (λ from K-12?)  
 W-1805 λc from W1681  
 W-1806 λc from W1681  
 W-1807 λc from 58-161

27, 28, 29, 30, 32, 35, 45  
 33, 39, 35, 36, 39, 40, 41, 44, 48, 49, 51  
 29, 25, 26, 27, 29  
 17,

## Bacilli

WB-1

29, 34

W13-4

34

H-267

59, 55, 57, 58, 59, 60, 71, 80

812

750E 1821

98

91

Subject

Ultraviolet effects -

Survival

K-12  
 S8-161  
 W 518  
 W-811  
 W-1177  
 W-1485  
 W-1603  
 W-1655  
 W-1655(882) = 1931  
 W-1673  
 W-1678  
 W-1681  
 W-1682  
 W-1831  
 W-1831(882)(W)(P)  
 W-1931  
 D<sub>A</sub> [S8-161(882)]  
 W-1932  
 H267  
 W1736  
 W1959(W<sup>+</sup>)  
 W1972(X<sup>+</sup>)  
 W1898(X<sup>+</sup>)  
 W1503(X<sup>+</sup>)  
 W1998(W<sub>g</sub>, X<sup>+</sup>)  
 W1436(X<sup>+</sup>)

$\lambda$   
 W1953(W<sup>+</sup>)

W1661

Survival curves

K-12  
 H267

Mice  
 W1832 for J.L.  
 W1931 for G.L.  
 Plague from 1m N112  
 W1736 galt

lympho sheathed out

Pages

				12, 17*, 19*, 20*, 22*, 23*, 25*, 26*, 53(ager)
				6, 8, 9*, 10*, 11*, 15, 18*
				68*(sig wth) 69*, 71(wth), 73(gm)
				1*, 90
				13,
				12, 17*, 19*, 20*, 22*, 23*, 64
				13,
				6, 7, 8, 11*, 15, 18*, 20*, 70*
				146*
				12*
				58*
				6, 8, 15, 53*
				6, 8, 15, 63*
				18*, 55, 64
				29*, 45*, 55*
				54*
				15
				62*
				57*, 59*, 60*, 64*, 66*, 68*, 73* (sig wth)
				66
				69*
				69*, 78*
				70*
				69a
				98*
				81
				80, 81
				81
				80
				3,
				3,
				76
				76
				77
				80
				104, 106

λ

# Phage Stocks - lysates

#	Source	titer					
1.	750 (gal <sub>1</sub> -)	$>2.4 \times 10^{10}$					
2.	902 (gal <sub>1</sub> -)	$4.9 \times 10^{10} \leftarrow ?$					
3.	K-12	$1.4 \times 10^{10}$	↓ dilution				
4.	58-161	$1.8 \times 10^9$					
5.	811 (sp. gal <sup>+</sup> )	$4.0 \times 10^{10}$	(contam?)				
6.	1821 (gal <sub>9</sub> -)	$1.0 \times 10^{10}$	(contam?)				
7.	K-12	$2.3 \times 10^{10}$	weak				
8.	1485 (filthate)	-					
9.	750+1821	$6.5 \times 10^9 \leftarrow ?$	(contam?)	0.1 ml / EMB gel gave no col	10/1		
10.	1439 (gal <sub>4</sub> -)	$1.1 \times 10^{10}$					
11.	811 (gal <sub>9</sub> -)	$1.7 \times 10^{10}$					
12.	811 (gal <sub>9</sub> -)	?					
13.	1736 (sp. gal <sup>+</sup> )	?					
14.	892 (gal <sub>3</sub> -)	$3.8 \times 10^9 \leftarrow ?$					
15.	K-12 (HEATED Δ)	-					
16.	1954	$>140 \times 10^5$					
17.	2096	$2.1 \times 10^{10}$					

SubjectPages

Wq-14

pr- verified  
pr+  
pr- tryp<sup>t</sup>- crosses  
lac- verified  
lac<sup>t</sup>(+<sub>1</sub>, +<sub>2</sub>, +<sub>3</sub>, +<sub>4</sub>)  
pr- tryp<sup>t</sup>- lac<sup>t</sup>

27, 28, 32, 34, 35, 36, 38, 39, 40, 41, 42, 56, 57, 58, 60, 61, 66, 67, 68, 85a  
35  
36  
35, 44, 46, 78  
50, 52  
45  
60, 61  
75

Wq-16

pr-  
pr- x<sup>t</sup>(1)  
pr- x<sup>t</sup>(2)

27, 28, 36, 37, 38, 39, 40, 41, 42, 55, 64, 67, 68, 75  
42, 47, 48, 49, 52  
53  
56 - not so on stretching

Phase summary

$$\frac{1682}{882} / \frac{1681}{881} = \lambda$$

Wq 14

W1584

$\text{pr}^- \text{ F}^+ \text{loc}^- \text{Malt} + \text{Suc}^+ \text{Gal} + \text{cello}^- \text{Phenyl} + \text{Acrit}^+ \text{Sudet} + V_1^R V_2^L V_{3,7}^R \lambda^L \rho^R \gamma^{370R}$   
stock

(pr-Deg)

#1, 2, 3, 4

pr-Las

(pr-Trypt)

pr+

W116

W1716

$\text{F}^+ \text{loc}^- \text{Suc}^+ \text{gal} + \text{cello}^- \text{Phenyl} + \text{Acrit}^+ \text{Sudet} + V_1^R V_2^L \lambda^R \rho^R \gamma^{370R}$  Lys for K-12

Stock

↓

pr-

pr<sup>-</sup>x<sub>1</sub>

pr<sup>-</sup>x<sub>2</sub>